GIBBS

Effect of Fineness of Sand On the Tensile Strength Of Cement Mortar

Civil Engineering
B. S.
1905

EFFECT OF FINENESS OF SAND

ON THE

TENSILE STRENGTH OF CEMENT MORTAR

BY

CHARLES HENRY GIBBS

THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

PRESENTED JUNE 1905

UNIVERSITY OF ILLINOIS

May 24, 1905

This is to certify that the thesis prepared under the immediate supervision of Instructor L. A. Waterbury by

CHARLES HENRY GIBBS

entitled THE EFFECT OF FINENESS OF SAND ON THE TENSILE STRENGTH OF CEMENT MORTAR

is approved by me as fulfilling this part of the requirements for the degree of Bachelor of Science in Civil Engineering

----

Head of Department of Civil Engineering

EFFECT OF FINENESS OF SAND ON THE TENSILE STRENGTH OF CEMENT MORTAR.

The use of cement mortar has become so general that numerous experiments have been made to determine the correct proportion of the ingredients and the proper materials to be used; but very few tests have been made to determine the relative strength of mortars made with sands having different degrees of fineness. Because there is a lack of data upon this subject and since a correct knowledge of the effect of fine or coarse sand in cement mortar is of importance the experiments described in this thesis were made. The primary object of these tests was to determine the effect of fineness of sand upon the tensile strength of cement mortar, but in addition to this they also give a comparison between the tensile strength of mortars made with limestone srceenings and with natural sand.

The tensile strength of about one hundred and fifty briquettes was determined. Four different degrees of fineness were used, of both natural and artificial sand (limestone screenings). Forty-eight specimens were tested at three different ages, viz., one, four and twelve weeks, making in all twenty-four tests.

The cement employed was Atlas American Portland, having a fineness as shown in table III. The sand used was ordinary building sand from a bank north of Urbana, Illinois. It was sharp and fairly clean, a small quantity rubbed between the hands leaving them unsoiled. The limestone screenings were from a quarry at Kankakee, Illinois. The fineness of the limestone screenings in given in table I and the fineness of the sand in table II.

The proportions of the mortar used was one part cement, by weight, to two parts sand. The quantity of water used for gauging was twelve per cent of the weight of the dry material.

The briquettes were mixed as follows: The sand and cement was weighed, placed on the mixing table, thoroughly mixed dry, a crater formed in the center, into which the water was poured. The material on the outer edge was turned into the crater by the aid of a trowel and as soon as the water was absorbed, which did not require more than a minute, the operation was completed by vigorously working the mixture with a trowel for about three minutes, or until all the particles were wet and well mixed. Then the mortar was placed in the moulds, pressed in firmly with the fingers and smoothed off with a trowel. The moulds containing the briquettes were covered with a damp cloth and left for one day. The briquettes were then removed from the moulds and placed in water to remain until tested.

The tests were made on the Fairbanks Improved Cement Testing Machine No. 3184 in the cement laboratory of the University of Illinois. Care was used in placing the briquettes in the clips of the testing machine, all sand or particles of mortar adhering to the clips were removed and the briquettes were carefully centered to avoid stresses due to bending. The load was applied at the rate of six hundred pounds per minute.

The tables and curves on the following pages show the results of the tests:

Table I.

Degree of Fineness Limestone Screenings.

Sieve No.	Amount Retained.	Per Cent.
4	34	3.4
10	521	52.1
20	219	21.9
30	44	4.4
50	55	5.5
74	26	2.6
100	22	2.2
Passing 100	79	7.9
Total.	1000	100.0

Table II.

Degree of Fineness Natural Sand.

Sieve No.	Amount Retained.	Per Cent.
4	10	1.0
10	173	17.3
20	214	21.4
30	122	12.2
50	338	33.8
74	85	8.5
100	33	3.3
Passing 100	25	2.5
Total.	1000	100.0

Table III

Degree of Fineness Atlas Cement.

Sieve No.	Amount Retained.	Per Cent.
50	3.5	3.5
74	16.9	16.9
100	38.0	38.0
200	23.5	23.5
Passing 200	18.1	18.1

TABLE IV.

EFFECT OF FINENESS ON THE TENSILE STRENGTH IN LBS PER SQ. IN. OF 1:2 CEMENT MORTAR MADE WITH NATURAL SAND.

AGE WHEN BROKEN.	NOT SIFTED.	RETAINED ON No.20.	RETAINED ON No.30.	PASSING No.30.
1 WEEK.	202	157	125	124
	153	126	110	80
	178	172	117	85
	151	115	129	108
	188	110	135	84
	155	125	137	124
MEAN.	171	134	125	101
4 WEEKS.	307	296	205	143
	294	274	187	144
	316	280	135	152
	245	333	160	143
	243	318	180	197
	285	299	185	210
MEAN.	282	300	175	165
12 WEEKS.	523	342	308	235
	445	356	248	267
	448	363	222	277
	380	497	222	265
	429	440	253	257
	475	440	197	230
MEAN.	450	406	242	255

TABLE V.

EFFECT OF FINENESS ON THE TENSILE STRENGTH IN LBS. PER SQ. IN. OF 1:2 CEMENT MORTAR MADE WITH LIMESTONE SCREENINGS.

Age When Broken.	Not Sifted	Retained on No. 20	Retained on No. 30.	Passing No 30.
1 Week.	219	110	138	71
	287	133	98	93
	216	206	165	100
	263	161	120	96
	221	215	87	119
	215	190	113	87
Mean.	237	189	120	94
4 Weeks.	208	148	138	193
	248	250	174	115
	270	184	180	179
	242	253	187	130
	230	179	180	186
	296	155	185	159
Mean.	249	195	176	159
12 Weeks.	396	278	266	204
	465	330	196	213
	365	327	203	236
	323	375	153	237
	334	236	183	178
	267	308	184	210
Mean.	358	309	198	213

TABLE VI.

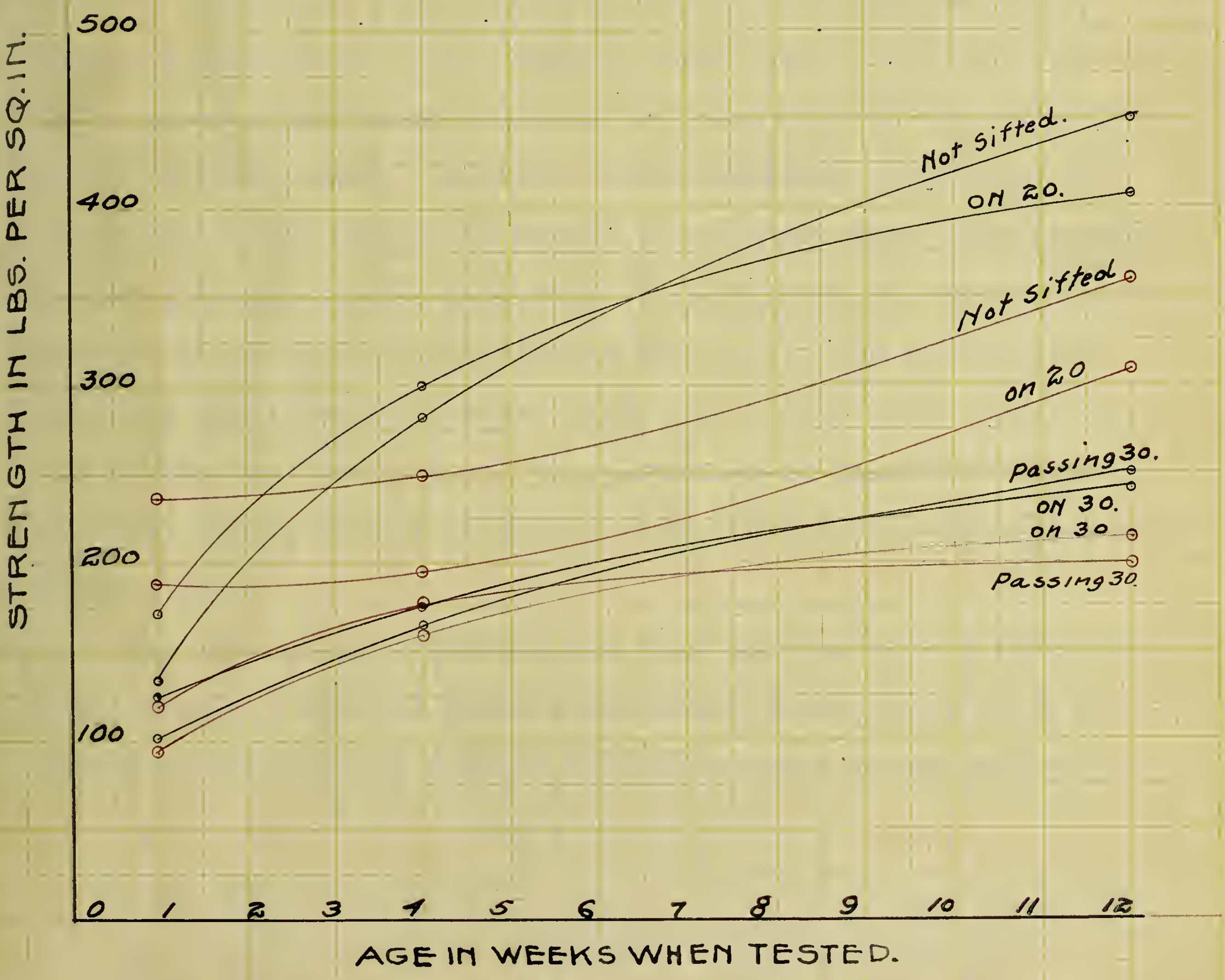
COMPARISON OF STRENGTH OF 1:2 CEMENT MORTAR, MADE WITH NATURAL SAND AND WITH LIMESTONE SCREENINGS.

Mean Values taken from TABLES IV and V

NATURAL SAND.				
AGE.	FINENESS.			
	NOT SIFTED.	RETAINED ON No. 20 SIEVE.	RETAINED ON No. 30 SIEVE.	PASSING No. 30 SIEVE.
1 WEEK.	171	134	125	101
4 WEEKS.	282	300	175	165
12 WEEKS.	450	406	242	255
LIMESTONE SCREENINGS.				
	FINENESS.			
	NOT SIFTED.	RETAINED ON No. 20 SIEVE.	RETAINED ON No. 30 SIEVE.	PASSING No. 30 SIEVE.
1 WEEK.	237	189	120	94
4 WEEKS.	249	195	176	159
12 WEEKS.	358	309	198	213

CURVES SHOWING EFFECT OF FINENESS ON THE TENSILE STRENGTH OF 1:2 CEMENT MORTAR MADE WITH NATURAL SAND AND WITH LIMESTONE SCREENINGS.

LIMESTONE SCREENINGS ————
NATURAL SAND ————



CONCLUSION.

These tests show that the unsifted sand gives greater tensile strength than that which has been sifted and that coarse sand is preferable to fine when all particles are of the same size. They also indicate that natural sand, when the set of mortar is complete has greater tensile strength than limestone screenings. It may be that the greater strength of the unsifted sand is due to the fact that the finer particles fill the voids between the coarser, thus decreasing the size of the voids and making a denser and stronger mortar.

Since the theory of a correct proportion of the ingredients is that the cement paste shall cover all the surfaces of the sand, it follows that with coarser sand there are fewer surfaces to be covered and hence a greater strength for mortar made with coarse grained sand. The fact that limestone screenings at early ages gives mortar as strong,or stronger than natural sand, is probably due to the fact that the particles of limestone are rougher and produce more friction when moving upon each other than the particles of natural sand, but at the later ages when the briquettes were broken, the particles of limestone were ruptured and seemed to give less strength than the particles of natural sand.

The limestone screenings had very much more very fine material than the natural sand, which might possibly give less strength owing to the greater number of voids to be filled.